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U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER
52433/682

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
10/070353

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE(S) CLAIMED
PCT/JP00/05774	(25.08.00) 25 August 2000	(26.08.99) 26 August 1999 (09.06.00) 9 June 2000

TITLE OF INVENTION
JOINING STRUCTURE

APPLICANT(S) FOR DO/EO/US
Masakazu SUGIMOTO, Masayuki OKIMOTO, Tetsumi KONDO, Shiro KITA, Masafumi HIGASA.

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification and marked-up specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: PCT/RO/101, first page of published WO 01/16438, International Search Report

Express Mail No.: EL 828170854US

U.S. APPLICATION NO if known, see 37 C F.R.1 5	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/070353	PCT/JP00/05774	52433/682

17. ☒ The following fees are submitted:	CALCULATIONS | PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):	
Search Report has been prepared by the EPO or JPO $890.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) $690.00	
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $710.00	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,000.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00	

ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	9 - 20 =	0	X $18.00	$ 0.00	
Independent Claims	2 - 3 =	0	X $84.00	$ 0.00	
Multiple dependent claim(s) (if applicable) **			+ $270.00		
TOTAL OF ABOVE CALCULATIONS =				$ 890.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
****Upon entry of Preliminary Amendment** **SUBTOTAL =**				$ 890.00	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$ 890.00	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$890.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

John J Kelly Jr
SIGNATURE

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26646
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451522

[52433/682]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Masakazu SUGIMOTO, et al.
Serial No.	Not Yet Assigned
Filing Date	Herewith
Title	JOINING STRUCTURE

PRELIMINARY AMENDMENT

Please amend the above-identified application as follows:

In the title:

--(Amended) JOINING STRUCTURE --

In the Claims:

Please cancel claims 4, and 6-8 without prejudice.

Please add the following new claims:

10. (New) A joining structure according to claim 2, characterized by bending one or both ends of each tabular member to the extent that each bent end is formed at a right angle to the direction of the principal stress.

11. (New) A joining structure according to claim 1, wherein the structural member has a coupling flange or a base plate, and one or more tabular members are disposed between the structural member and the coupling flange or base plate.

12. (New) A joining structure according to claim 1, wherein each tabular member serves as a fixture for one or more members to be joined.

13. (New) A joining structure according to claim 1, wherein a tabular member serves as a fixture for a secondary member.

REMARKS

This Amendment is being submitted in order to eliminate multiple dependent claims.

It is respectfully submitted that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Attached hereto is a marked-up version of the changes made to the title by the current amendment. The attached page is captioned "Versions with markings to show changes made."

Respectfully submitted,

Dated: FEB 25, 2002

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451515 EL828170854US

VERSION WITH MARKINGS TO SHOW CHANGES MADE

The title has been amended as follows:

-- [CONNECTED STRUCTURAL BODY] JOINING STRUCTURE --

DESCRIPTION

JOINING STRUCTURE

Technical Field

The present invention relates to a joining structure constructed by attaching one or more tabular members, such as reinforcing ribs, etc. or anchor bolts, to a structural member which takes various forms.

Background Art

A joining structure, as shown in Fig. 22 or 23, has been conventionally used for a join, for instance, between a steel base structure and a foundation. The conventional joining structure is formed by welding a bolt connection base plate 11 to an end of a structural member 10 and reinforcing the joining structure with reinforcing ribs 12 attached between the structural member 10 and the base plate 11. The reinforcing ribs 12 are tabular members extending in the direction of the principal stress of the structural member 10 and are attached to protrude from the surface of the structural member 10 in the shape of a T.

In a conventional joining structure as described above, however, there is a problem that, when a bending moment is applied on the structural member 10, a large out-of-plane bending stress concentrates at the portions of the structural member 10 near the toes of the reinforcing ribs 12 and, as a consequence, the performance of the structure is deteriorated. Another problem is that, when the reinforcing ribs 12 are welded to the structural member 10, structural defects are likely to occur in the boxing welding portions at the upper ends of the reinforcing ribs 12 as a result of the combined effects of the residual stress caused by welding heat and the material degradation of the heat affected zones at the weld toes, causing the proof stress and the

fatigue property to deteriorate. Those problems are common to many types of joining structures in which reinforcing ribs 12 are welded to structural members 10 in the form of T-joints and, in view of this, the Japanese Society of Steel Construction points out, in "Guideline for Fatigue Design of Steel Structures and Its Interpretation", that a join in which a gusset is welded by fillet welding or groove welding adversely affects the proof stress and fatigue property of a steel member and, therefore, attention has to be paid to this in the design of structures.

Disclosure of the Invention

The present invention provides a joining structure composed of a structural member and one or more tabular members, or a structural member and anchor bolts, which joining structure can: solve the above-mentioned conventional problems; significantly alleviate the stress concentration at the toes of the tabular members such as the reinforcing ribs, etc.; greatly alleviate the residual stress caused by welding heat in the case of welding the tabular members; and, as a result, significantly improve the proof stress and the fatigue property compared with a conventional joining structure.

More specifically, the present invention is a joining structure having one or more tabular members protruding from the surface of a structural member and is characterized by bending one or both ends of each tabular member. Note that the above expression "one or both ends of each tabular member" means one or both end portions of each tabular member where the tabular member contacts with a structural member which is a base material. Further, in the present invention, it is preferable that the joining structure is a structure wherein a tabular member is a reinforcing rib protruding from the surface of a structural member in the shape of T so that the tabular member extends in the direction of the principal

stress of the structural member and one or both ends of the reinforcing rib is/are bent in a direction deviating from the direction of said principal stress.

It has to be noted that it is preferable that one or both ends of a tabular member is/are bent in the shape of an gradual curve and to the extent that each bent end of the tabular member is formed at a right angle to the direction of the principal stress. Only one or both ends of a tabular member may be bent, or the whole body thereof may be bent in the shape of U or V.

The structural member may have a coupling flange or a base plate. In that case, a tabular member may be placed between the structural member and the coupling flange or between the structural member and the base plate, or otherwise may be used for fixing a join member, or yet may be used for fixing a secondary member.

Further, the present invention is applicable also to a type of joining structure wherein anchor bolts extending in the direction of the principal stress of a structural member are welded to the surface of the structural member and an end of each anchor bolt is bent in a direction deviating from the direction of the principal stress.

As described above, in the present invention, the rigidity at one or both ends of a tabular member decreases by bending the end(s) (toe(s)) of the tabular member such as a reinforcing rib, etc., preferably, in a direction deviating from the direction of the principal stress of a structural member. As a result, when a load is applied on the structural member, the stress concentration near the end(s) of the tabular member is significantly alleviated, and, when the tabular member is welded, the residual stress caused by welding heat near the end(s) of the tabular member is significantly alleviated as well. By this, the proof stress and the fatigue property of the joining structure is largely improved compared with a conventional joining structure.

Specific numerical values are explained later.

Brief Description of the Drawings

Fig. 1 is a perspective view showing a first embodiment of the present invention.

Fig. 2 is a perspective view showing a second embodiment of the present invention.

Fig. 3 is a perspective view showing a third embodiment of the present invention.

Fig. 4 is a stress concentration chart obtained through a finite element (FEM) analysis of the joint structure according to the second embodiment.

Fig. 5 is a stress concentration contour of a conventional joining structure having tabular reinforcing ribs.

Fig. 6 is a perspective view showing a fourth embodiment of the present invention.

Fig. 7 is a perspective view showing a fifth embodiment of the present invention.

Fig. 8 is a perspective view showing a sixth embodiment of the present invention.

Fig. 9 is a perspective view showing a seventh embodiment of the present invention.

Fig. 10 is a perspective view showing an eighth embodiment of the present invention.

Fig. 11 is a perspective view showing a ninth embodiment of the present invention.

Fig. 12 is a perspective view showing a conventional joining structure corresponding to the ninth embodiment and a modified example of the ninth embodiment.

Fig. 13 is a perspective view showing a tenth embodiment of the present invention.

Fig. 14 is a perspective view showing a conventional joining structure corresponding to the tenth embodiment.

Fig. 15 is a perspective view showing an eleventh embodiment of the present invention.

Fig. 16 is a perspective view showing a conventional

joining structure corresponding to the eleventh embodiment.

Fig. 17 is a perspective view showing a twelfth embodiment of the present invention.

Fig. 18 is a perspective view showing a conventional joining structure corresponding to the twelfth embodiment.

Fig. 19 is a perspective view showing a thirteenth embodiment of the present invention.

Fig. 20 is a perspective view showing a conventional joining structure corresponding to the thirteenth embodiment.

Fig. 21 is a graph of the S-N curves showing the results of the fatigue strength test described in Example.

Fig. 22 is a perspective view showing a conventional joining structure.

Fig. 23 is a perspective view showing another conventional joining structure.

Fig. 24 is a front elevation view of the joining structure shown in Fig. 3.

Fig. 25 is a plan view of the joining structure shown in Fig. 3.

Fig. 26 is a front elevation view of the joining structure shown in Fig. 6.

Fig. 27 is a plan view of the joining structure shown in Fig. 6.

Fig. 28 is a front elevation view of the joining structure shown in Fig. 7.

Fig. 29 is a plan view of the joining structure shown in Fig. 7.

Fig. 30 is a front elevation view of the joining structure shown in Fig. 8.

Fig. 31 is a plan view of the joining structure shown in Fig. 8.

Fig. 32 is a front elevation view of a modified example of the joining structure shown in Fig. 2.

Fig. 33 is a plan view of the modified example of the joining structure shown in Fig. 2.

Best Mode for Carrying out the Invention

Preferred embodiments for carrying out the present invention are described hereafter.

(A joint structure of a structural member and a coupling flange)

Fig. 1 is a perspective view showing a first embodiment of the present invention, wherein numerals indicate the following: 1 designates a structural member such as a steel pipe to be coupled to another; 2 a coupling flange welded to an end of the structural member 1 and used for bolt connection with another structural member; and 3 a reinforcing rib attached between the structural member 1 and the coupling flange 2 so as to protrude in the shape of T. In this case, the reinforcing ribs 3 are welded in the form of T-joints. The direction of the principal stress of the structural member 1 is the direction of the central axis of the structural member in Fig. 1. As seen in the figure, each of the reinforcing ribs 3 is bent in the shape of U, but it extends, as a whole, in the direction of the principal stress of the structural member 1. The end (toe) 4, which is located opposite the coupling flange, of a reinforcing rib 3 is bent in the shape of an gradual curve and to the extent that the bent end of the reinforcing rib is formed at a right angle to the direction of the principal stress.

The reinforcing ribs 3 are welded not only to the structural member 1 but also to the coupling flange 2, the welding to the coupling flange 2 being done by boxing welding. It is preferable to form a scallop at each of the inside corners of each reinforcing rib 3 to secure reliable welding work.

In the joining structure constructed as described above, as the end 4 of a reinforcing rib 3 is bent in a

direction deviating from the direction of the principal stress of the structural member 1, the end 4 of a reinforcing rib 3 can be formed into a low rigidity structure. As a result, not only the stress concentration at the end 4 of a reinforcing rib 3 but also the residual stress caused by welding heat of the welded portion are significantly alleviated and, thus, the proof stress and the fatigue property of the joining structure are significantly improved.

To fully enjoy the above effect, it is desirable that the radius of curvature r of the end 4 of a reinforcing rib 3 is set at not less than 3 times its thickness t. If the radius of curvature r is smaller than 3 times of the thickness t, the material of the reinforcing rib 3 is likely to be deteriorated during bending the reinforcing rib 3 and, besides, the effect of lowering the rigidity decreases.

The coupling flanges 2 of the first embodiment are coupled to each other using bolts 6 in the same manner as in a conventional flange coupling method. While there is no specific restriction as to the number and positions of the bolts 6, when each of the bolts is located between the two legs of each of the reinforcing ribs 3 bent into the shape of U as shown in Fig. 1, there is the advantage that the bolts are protected from physical impact from the outside and from a corrosive environment. In any of the embodiments described hereinafter, the pipe constituting a structural member 1 is shown as a round steel pipe in any of relevant drawings, but it has to be noted that a square steel pipe may be used in place of the round pipe, or a section steel may be used as the structural member 1 as well.

(A joining structure of a structural member and a base plate)

In the second embodiment shown in Fig. 2, the structural member 1 is a base structure consisting of a steel pipe, and numeral 5 indicates a base plate for

fixing the structural member 1 to a foundation. Reinforcing ribs 3 bent into the shape of U are welded by T-joint weld between the structural member 1 and the base plate 5 so as to protrude in the shape of T, in the same manner as in the first embodiment. In the embodiment shown in Fig. 2, each of the reinforcing ribs 3 is cut slantwise so that its width becomes smaller towards the end 4, making the rigidity of the end 4 even smaller. Note that the position of each bolt 6 to fix the base plate 5 to a foundation may be outside the legs of each reinforcing rib 3, as seen in the third embodiment shown in Fig. 3.

A stress concentration contour obtained through afinite element (FEM) analysis of the joining structure according to the second embodiment is shown in Fig. 4 and another stress concentration contour of a conventional joining structure having tabular reinforcing ribs is shown in Fig. 5. These figures show, in contour lines, the distribution of the stress forming around the reinforcing ribs 3 when horizontal loads of the same amount are applied to the upper ends of respective structural members 1, and the unit of the numerical figures in the charts is MPa. It is clear from the comparison of the charts that the stress concentration around the reinforcing rib 3 according to the present invention is significantly alleviated, compared with the case of the conventional technology.

The fourth embodiment shown in Fig. 6 is a joining structure in which two adjacent reinforcing ribs 3 shown in Fig. 3 are connected into one piece. In this case too, the end 4 of a reinforcing rib 3 is bent to the extent that the bent end of the reinforcing rib 3 is formed at a right angle to the direction of the principal stress of the structural member 1 and, thus, the same effect as that of the other embodiments described above can be obtained.

In the fifth embodiment shown in Fig. 7, the

reinforcing ribs 3 disposed between the structural member 1 and the base plate 5 are formed into the shape of V. The legs of each reinforcing rib 3 slightly incline with respect to the direction of the principal stress of the structural member 1, but the centerline of the whole reinforcing rib 3 extends in the direction of the principal stress. The other structure and its functional effects are the same as the other embodiments described before.

Whereas the reinforcing ribs 3 are bent into the shape of U or V in the embodiments described above, the top end of a tabular reinforcing rib 3 may be bent so as to deviate from the direction of the principal stress of the structural member 1 and to form the shape of an upside-down J, as seen in the sixth embodiment shown in Fig. 8. In a joining structure having this type of construction too, the rigidity at the end 4 of the reinforcing rib 3 is low against the principal stress of the structural member 1 and, therefore, the same effect as described before can be obtained.

The whole body of a reinforcing rib 3 may incline as seen in the seventh embodiment shown in Fig. 9. In this case too, the end 4 of the reinforcing rib 3 may be bent significantly. In the eighth embodiment shown in Fig. 10, two reinforcing ribs 3 each having the shape of an upside-down J as shown in Fig. 8 are put together back-to-back to form a reinforcing rib 3 roughly in the shape of T.

Though it is preferable to bend the end 4 of the reinforcing rib 3 so as to form an gradual curve as shown in attached drawings, it is also possible to bend it linearly. The same effects as described before can be obtained also in that case since the end 4 of the reinforcing rib 3 has a low rigidity against the principal stress of the structural member 1. In view of the fact that another stress concentration occurs at the bend, however, it is preferable, as a conclusion, to bend

the reinforcing rib 3 so as to form an gradual curve.
(A joining structure of a structural member and reinforcing ribs for fixing joining members)

Whereas two structural members 1 (steel pipes) are coupled using coupling flanges 2 in the first embodiment shown in Fig. 1, the ninth embodiment shown in Fig. 11 represents a case where reinforcing ribs 3 are used as steel pipe joints. When this type of joining structure is employed, conventionally, a tabular steel pipe joint 7 as shown in the right-hand part of Fig. 12 is welded to an end of each steel pipe and the steel pipes are coupled using bolts or rivets, but the stress concentration does occur at the end of the steel pipe joint 7 also in this case. When each reinforcing rib 3 whose end 4 is bent as shown in Fig. 11 or the left-hand part of Fig. 12 is used, however, not only the stress concentration but also the residual stress caused by welding heat can be alleviated. Fig. 11 shows a case where reinforcing ribs 3 are bent into the shape of U, and the left-hand part of Fig. 12 shows another case where only the end 4 of each tabular reinforcing rib 3 is bent.
(A joining structure of a structural member and a reinforcing rib for fixing a secondary member)

The tenth embodiment shown in Fig. 13 is a joining structure wherein a reinforcing rib 3 for fixing a secondary member 8 is welded in the shape of T to the side wall of a steel tube constituting a structural member 1. This reinforcing rib 3 also extends in the direction of the principal stress of the structural member 1 and the upper and lower ends of the reinforcing rib 3 are bent in directions deviating from the direction of the principal stress of the structural member 1. By this structure, as in the cases of the other embodiments, the stress concentration at the rib ends and also the residual stress caused by welding heat can be alleviated compared with the conventional structure shown in Fig. 14.

The eleventh embodiment shown in Fig. 15 is a case where the present invention is applied to a gusset structure for a horizontal lateral bracing. In this case, the structural member 1 is an I-beam installed horizontally and the direction of its principal stress is horizontal. A reinforcing rib 3 whose both ends are bent is welded horizontally onto a side of the structural member 1 by T-joint weld, and a horizontally extending secondary member 8 is fixed to the reinforcing rib 3. Fig. 16 is a view showing a conventional gusset structure for a horizontal lateral bracing; the stress concentration at the ends of the reinforcing rib is large since the reinforcing rib used here is a flat plate. However, when the structure shown in Fig. 15 is employed, the stress concentration at the ends and also the residual stress caused by welding heat can be alleviated.

The twelfth embodiment shown in Fig. 17 is a case where the present invention is applied to a gusset structure for a transverse bracing. In this case too, the structural member 1 is an I-beam installed horizontally, but the direction of its principal stress is vertical. A reinforcing rib 3 whose both ends are bent is welded vertically onto a side of the structural member 1 by T-joint weld, and a secondary member 8 extending aslant upward is fixed to the reinforcing rib 3. The stress concentration at the ends of the reinforcing rib 3 and the residual stress caused by welding heat are significantly alleviated compared with the conventional gusset structure for a transverse bracing shown in Fig. 18.

(A joining structure of a structural member and anchor bolts)

Whereas any of the joining structures heretofore described is a joining structure having a structural member 1 and one or more reinforcing ribs 3, the thirteenth embodiment shown in Fig. 19 is a structure wherein anchor bolts 9 are welded to an end of a

structural member 1. In this case too, the anchor bolts 9 extend in the direction of the principal stress of the structural member 1. Whereas stress concentrates at the ends of the anchor bolts in the conventional anchoring structure shown in Fig. 20, when an end of each anchor bolt 9 is bent so as to deviate from the direction of the principal stress of the structural member 1 as seen in Fig. 19, not only the stress concentration is alleviated but also the residual stress caused by welding heat is significantly alleviated.

The front elevation views and plan views of the embodiments shown in Figs. 3, 6, 7 and 8 described above are given in Figs. 24 to 31. Figs. 32 and 33 are the front elevation view and plan view, respectively, of a modified example of the embodiment shown in Fig. 2.

In the embodiments of the present invention described above, a tabular member is a reinforcing rib and is fixed by welding to a structural member so as to protrude from its surface but, needless to say, the formations are not necessarily restricted to those described above: it may be formed by any suitable method such as press work, cutting, etc.

Example

A fatigue strength test was carried out for the purpose of confirming the effect of the present invention described above.

Two kinds of test pieces, one according to a conventional technology and the other to the present invention, were prepared for the test. The test pieces according to the conventional technology were structured as shown in Fig. 22, wherein a steel pipe 1 m in length was fixed upright onto a base plate 22 mm in thickness and its base portion was reinforced with conventional vertical ribs. The test pieces according to the present invention were structured as shown in Fig. 2, wherein a steel pipe 1 m in length was fixed upright onto a base

plate 22 mm in thickness and its base portion was reinforced with U-shaped reinforcing ribs. CO_2 gas shielded arc welding was employed for all the welding work, and the steel grade of all the steel sheets used for the test was Japanese Industrial Standard SM400.

The fatigue strength of each test piece under a bending load imposed on the steel pipe was measured by a known method. The results are shown in Fig. 21. As seen in the figure, whereas the measurements of the test pieces according to the conventional technology were in the level of Grade G of the design service life curves defined in the design specification of railway bridges, the measurements of those according to the present invention corresponded to Grades A to B. Thus, it was confirmed that the fatigue strength was significantly improved by employing the structure according to the present invention.

Industrial Applicability

As explained above, by the present invention, the stress concentration and residual stress caused by welding heat occurring at a toe of a tabular member in a joining structure can be significantly alleviated and, as a result, the proof stress and fatigue property of the joining structure can be greatly improved compared with a conventional joining structure. The present invention, therefore, can greatly contribute to improving the reliability of a joining structure in widely varied uses, as shown in the embodiments of a present invention, including the anchoring structure of a steel pole base such as an illumination pole and the like.

CLAIMS

1. A joining structure having one or more tabular members protruding from the surface of a structural member, characterized by bending one or both ends of each tabular member.

2. A joining structure according to claim 1, characterized in that: each tabular member is a reinforcing rib extending in the direction of the principal stress of the structural member and protruding in the shape of T; and one or both ends of each reinforcing rib is/are bent in a direction deviating from the direction of said principal stress.

3. A joining structure according to claim 1, characterized by bending one or both ends of each tabular member in the shape of an gradual curve.

4. A joining structure according to claim 2 or 3, characterized by bending one or both ends of each tabular member to the extent that each bent end is formed at a right angle to the direction of the principal stress.

5. A joining structure according to claim 2, characterized by bending each tabular member into the shape of U or V.

6. A joining structure according to any one of claims 1 to 5, wherein the structural member has a coupling flange or a base plate, and one or more tabular members are disposed between the structural member and the coupling flange or base plate.

7. A joining structure according to any one of claims 1 to 5, wherein each tabular member serves as a fixture for one or more members to be joined.

8. A joining structure according to any one of claims 1 to 5, wherein a tabular member serves as a fixture for a secondary member.

9. A joining structure wherein anchor bolts extending in the direction of the principal stress of a structural member are welded to the surface of the structural member, characterized by bending an end of

each anchor bolt in a direction deviating from the direction of said principal stress.

ABSTRACT

The present invention provides a joining structure capable of greatly improving the proof stress and the fatigue property by alleviating the stress concentration and residual stress caused by welding heat at one or both ends of a tabular member.

In the present invention, one or both ends 4 of a tabular member 3 such as a reinforcing rib, fixed to the surface of a structural member 1 in the direction of the principal stress of the structural member 1 so as to protrude in the shape of T, is/are bent in a direction deviating from the direction of the principal stress and, by this, the rigidity at the end(s) 4 of the tabular member 3 decreases and the stress concentration is alleviated. It is preferable to bend one or both ends of a tabular member 3 in the shape of an gradual curve and to the extent that each bent end is formed at a right angle to the direction of the principal stress. The tabular member may have the shape of a flat plate, or it may be bent so that it has the shape of U or V as a whole. Further, the tabular member may be welded to a structural member or formed as an integral part of a structural member.

Fig. 1

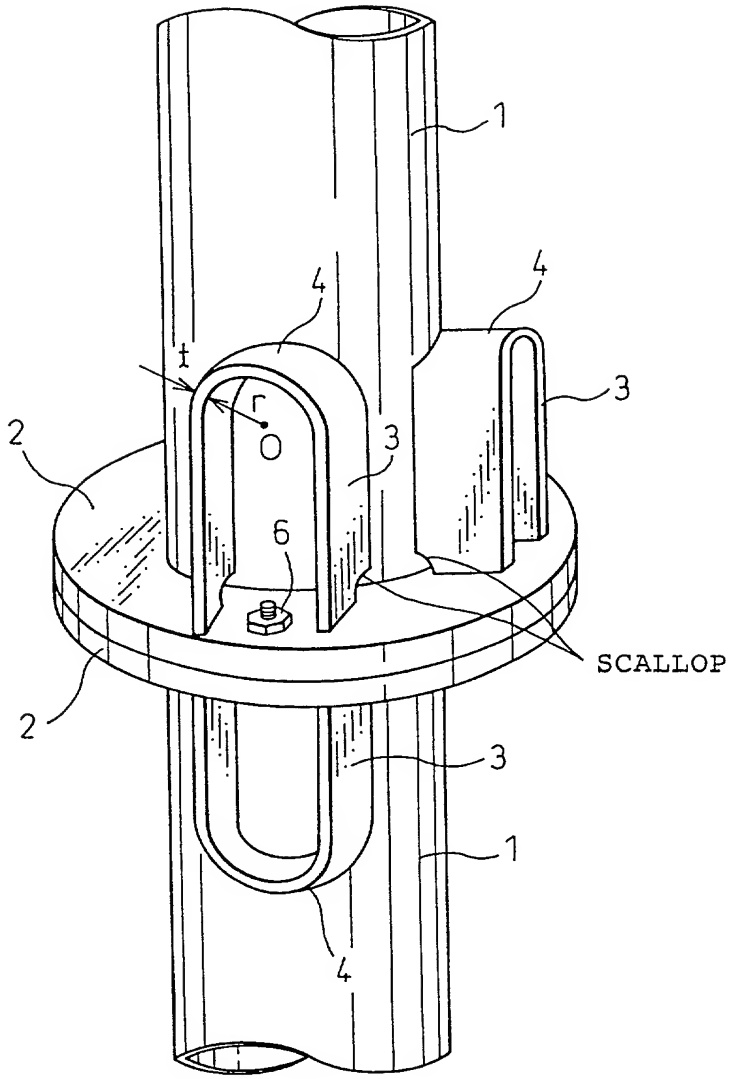


Fig. 2

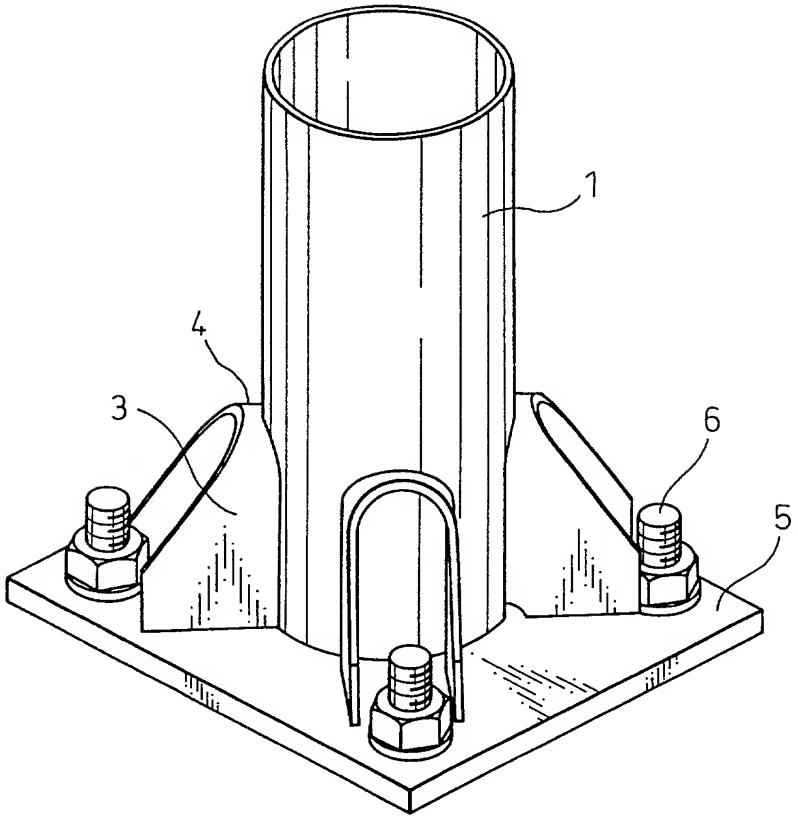


Fig. 3

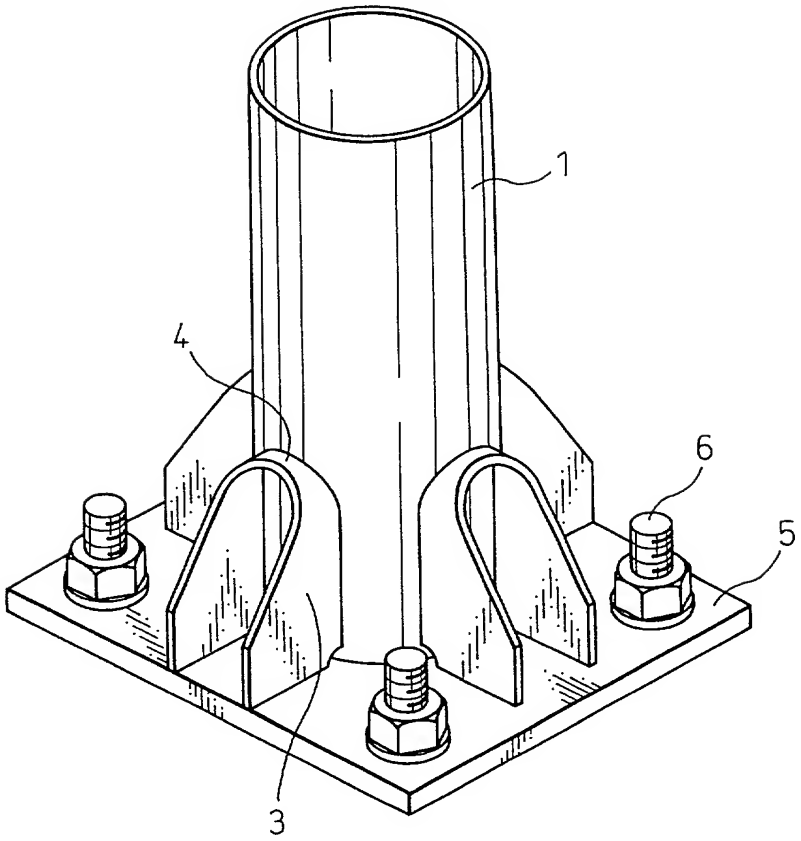
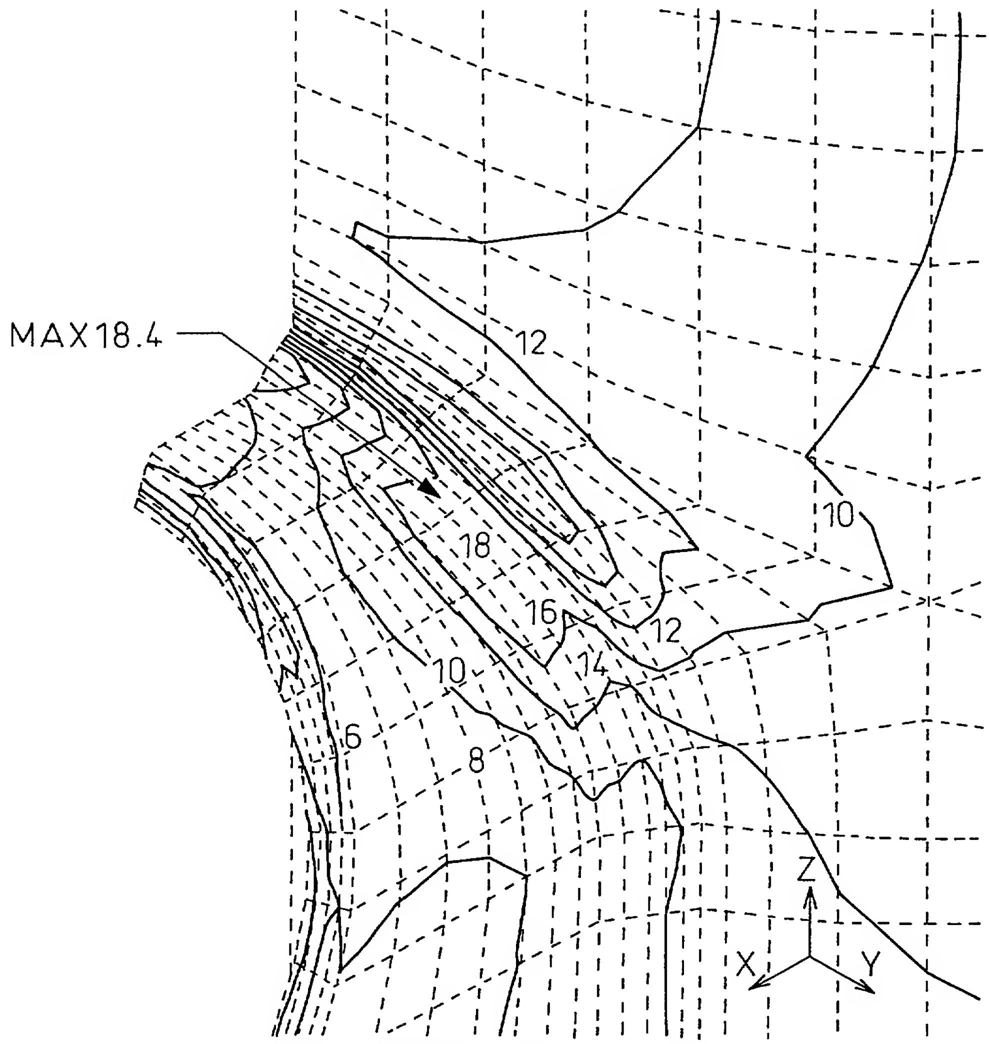
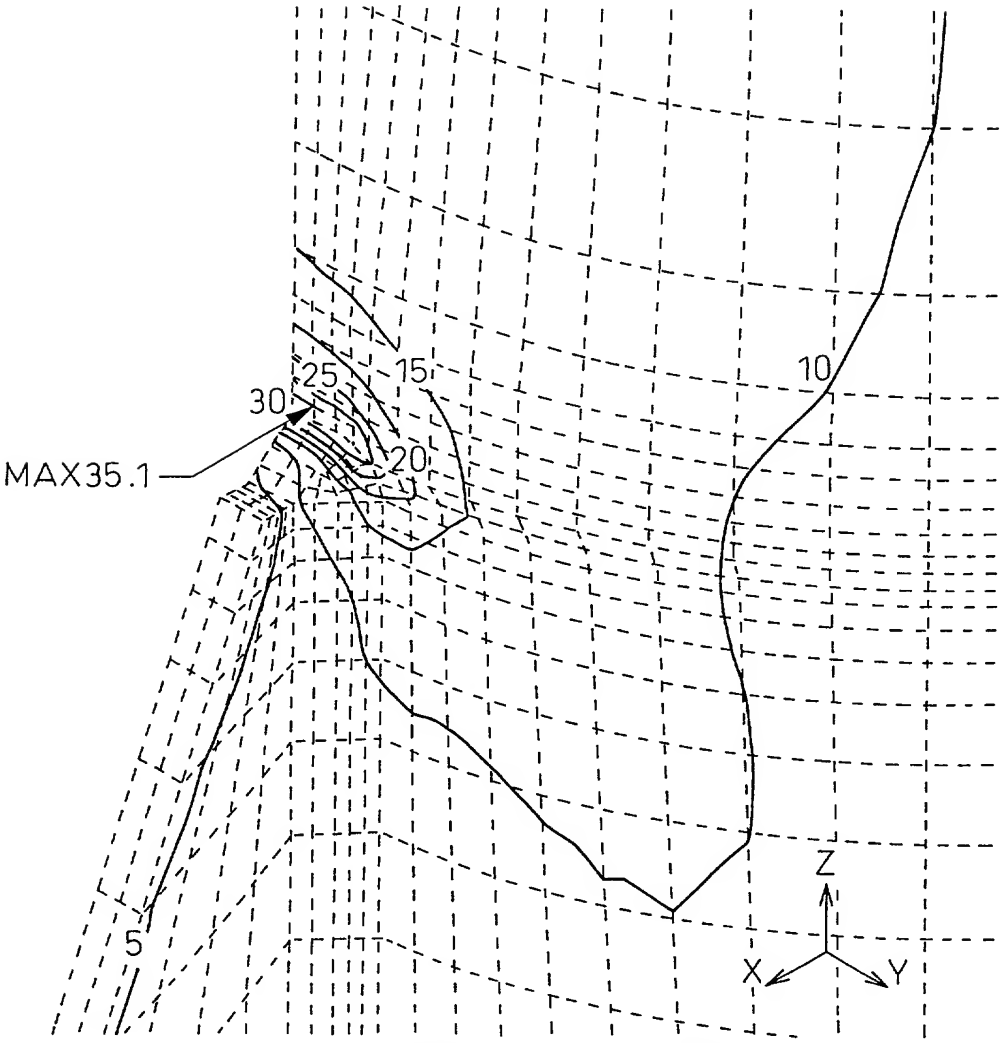


Fig. 4



fa-4 elastic (fa-4-a.dat)
Equivalent Von Mises Stress

Fig.5



fa-1 elastic (fa-1-a.dat)
Equivalent Von Mises Stress

Fig. 6

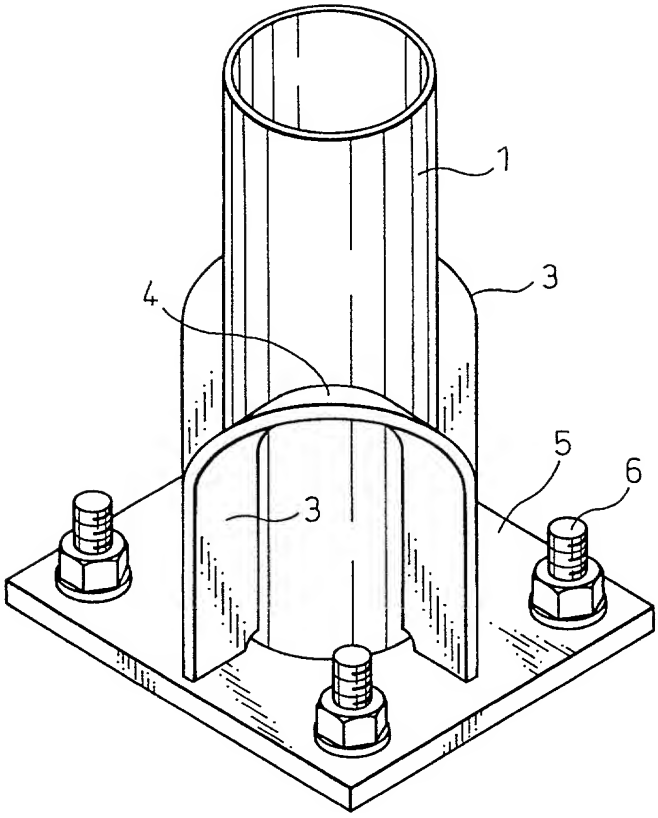


Fig. 7

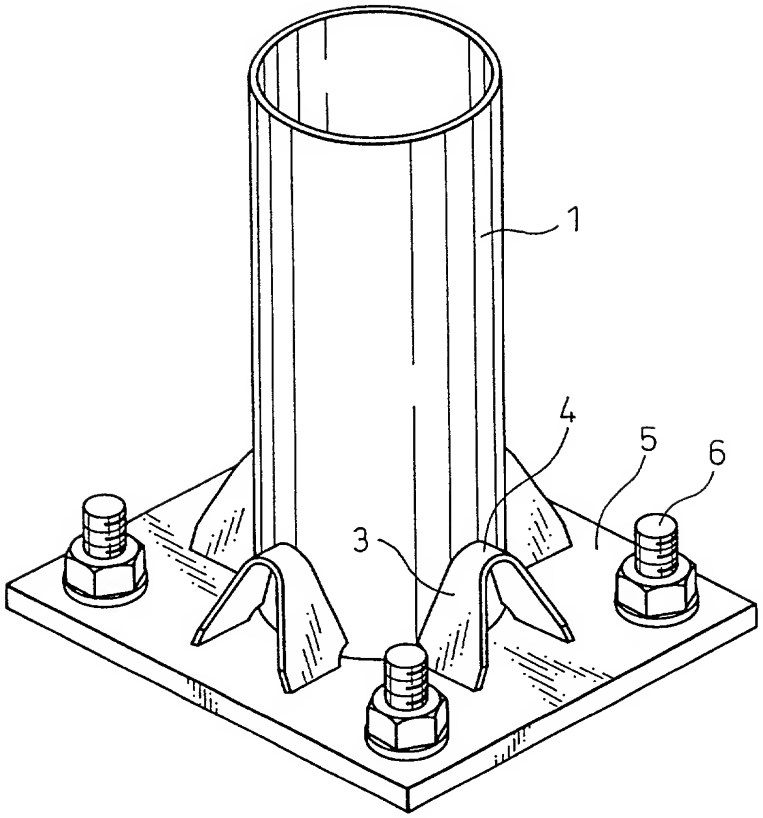


Fig. 8

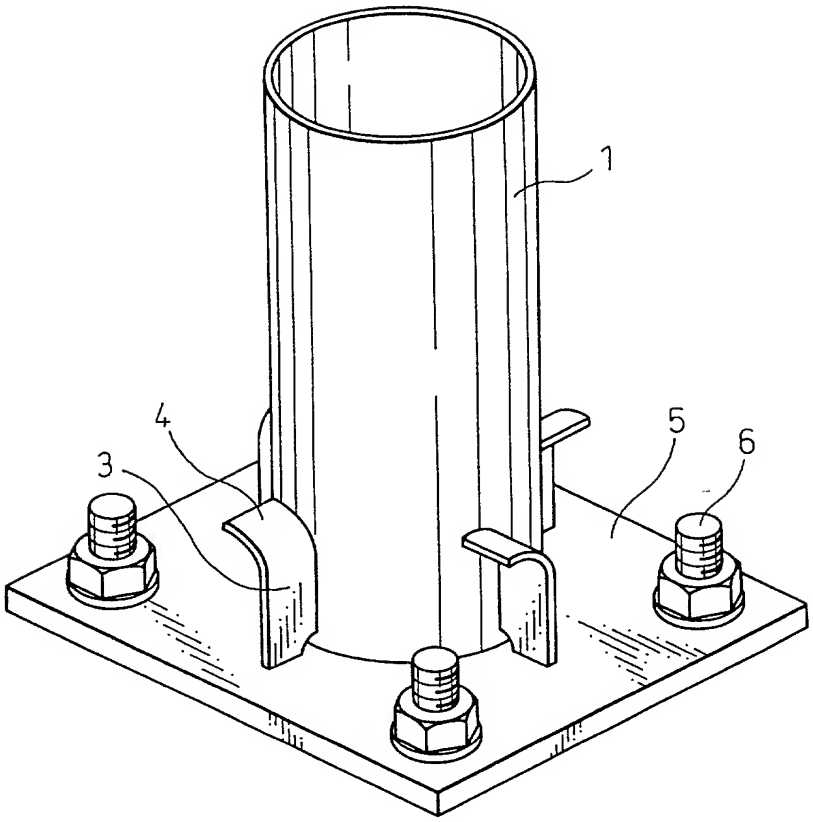


Fig.9

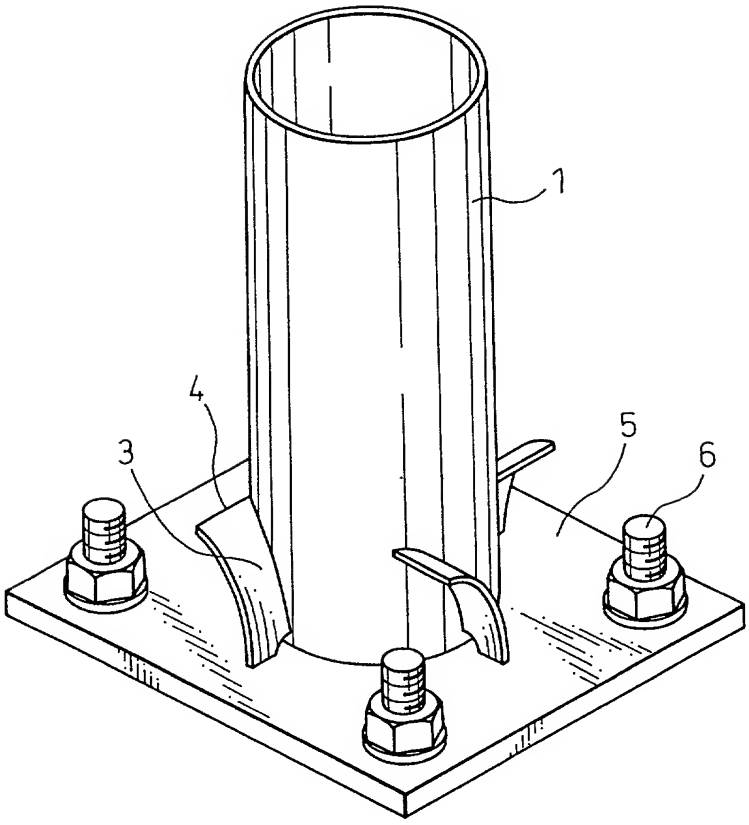


Fig.10

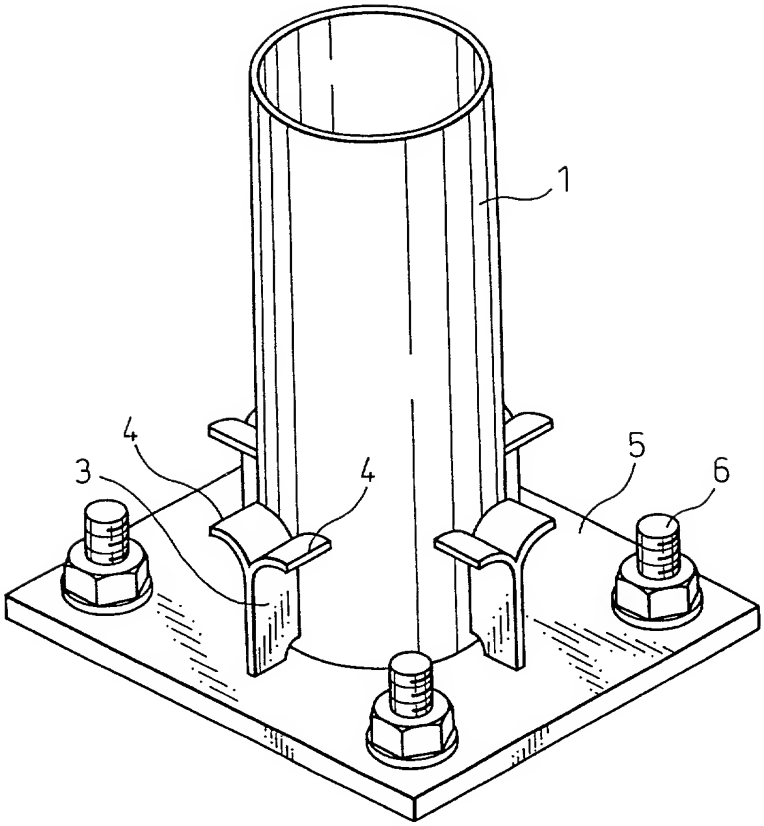


Fig.11

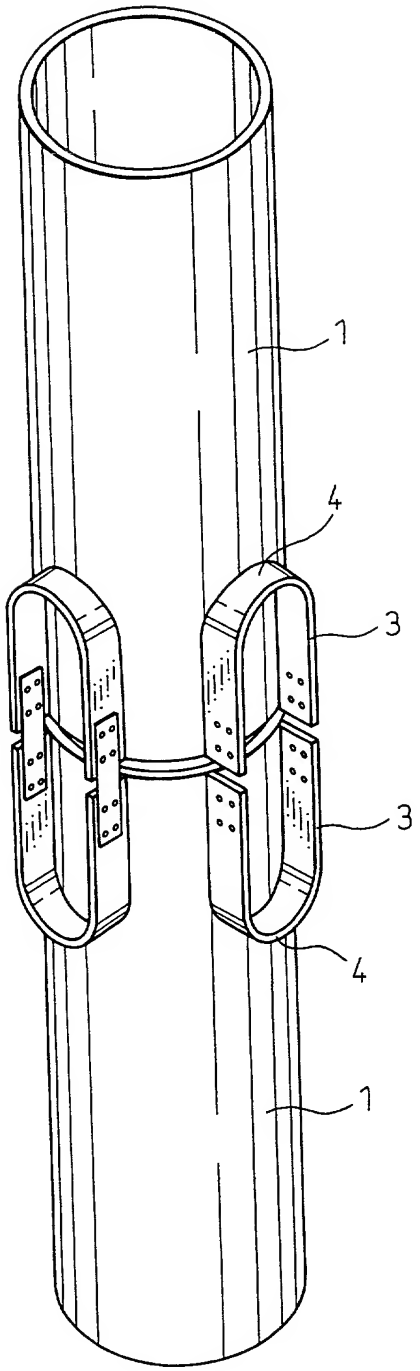


Fig. 12

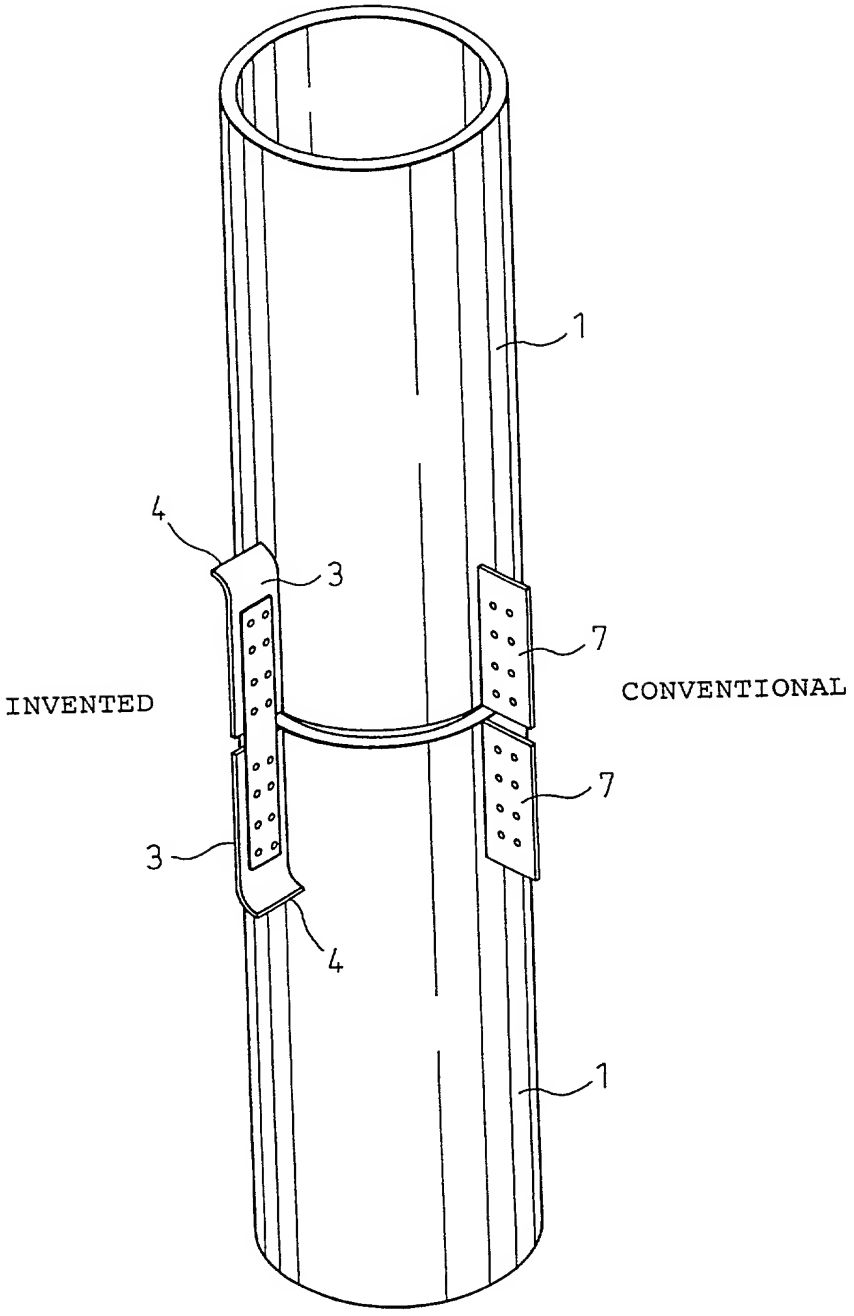


Fig.13

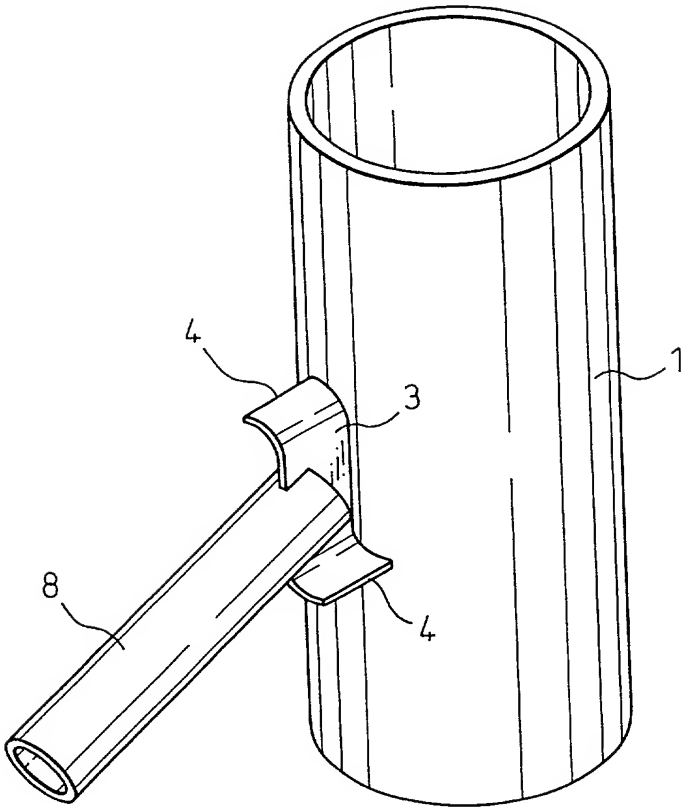


Fig.14

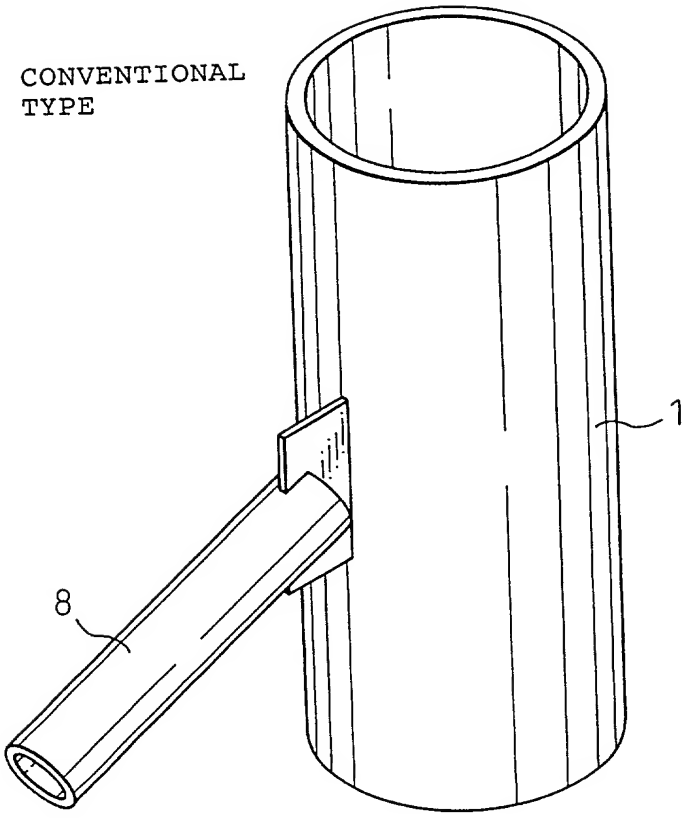


Fig.15

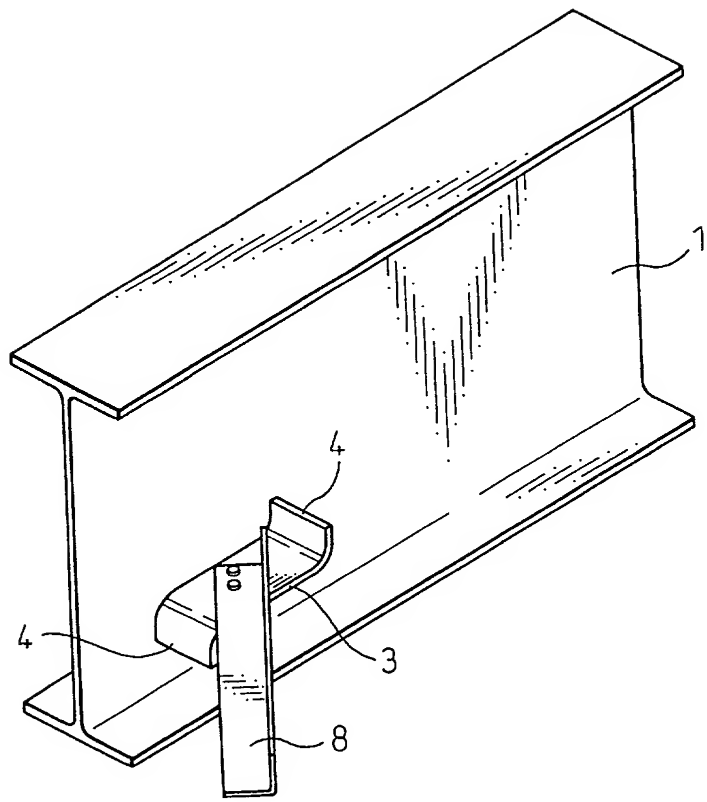


Fig.16

CONVENTIONAL TYPE

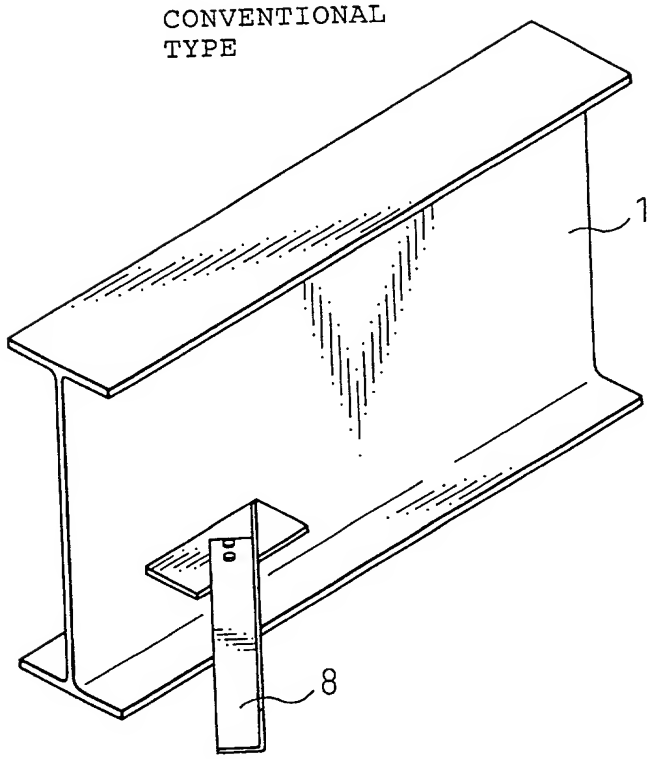


Fig.17

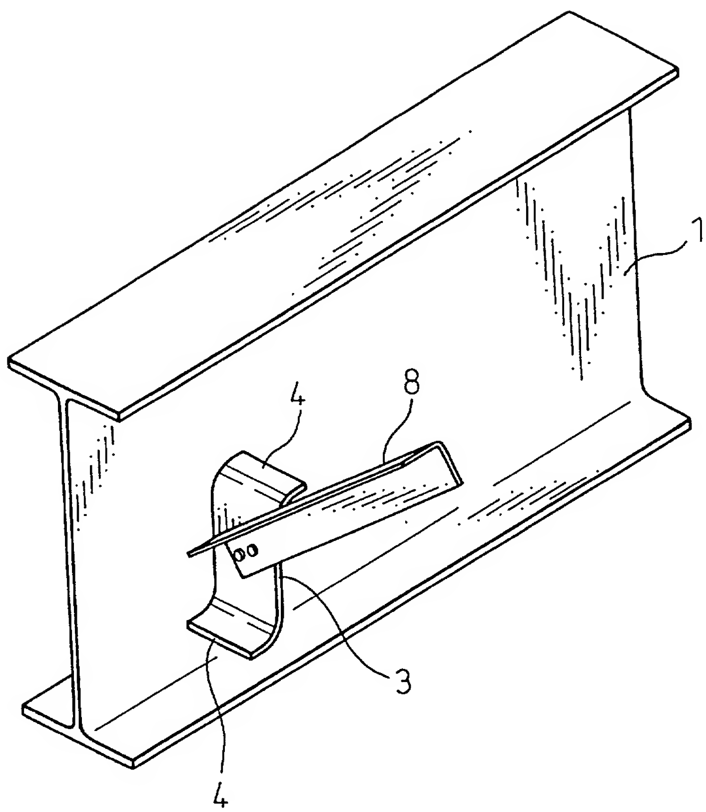


Fig. 18

CONVENTIONAL TYPE

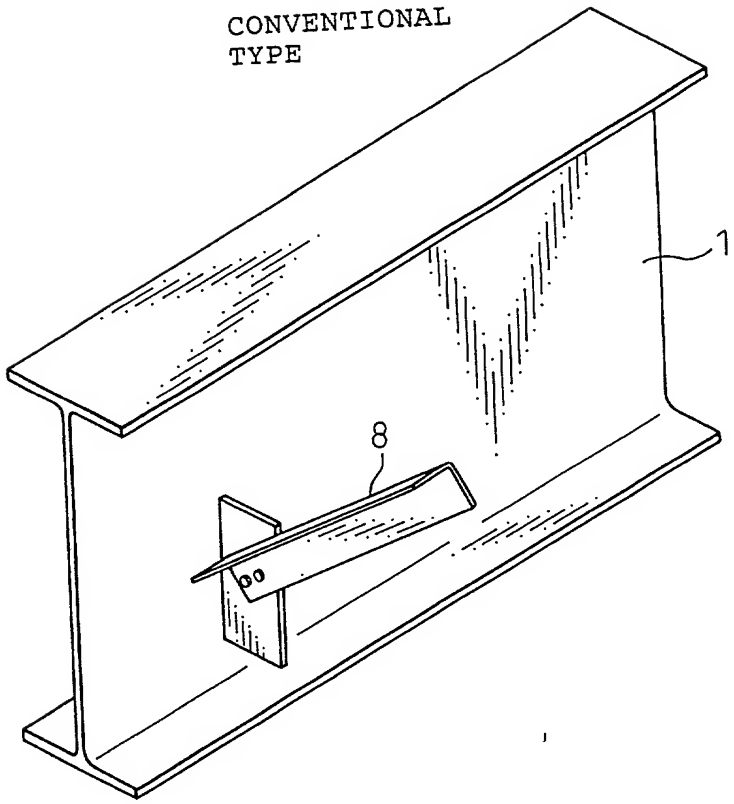


Fig.19

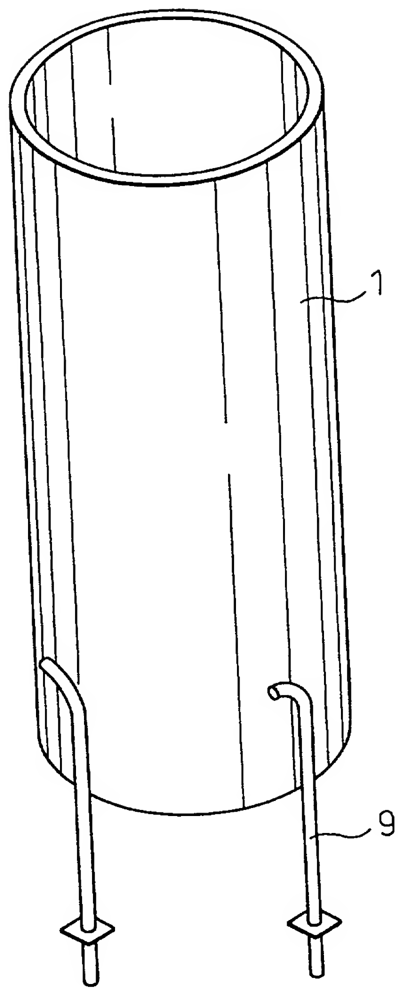


Fig. 20

CONVENTIONAL TYPE

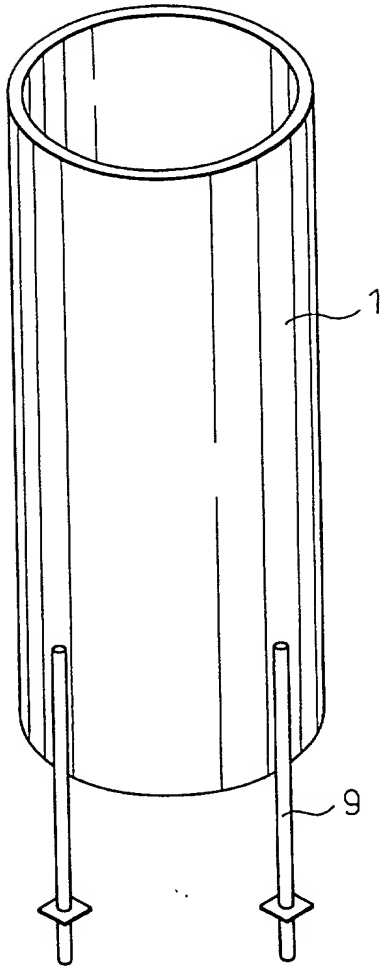


Fig.21

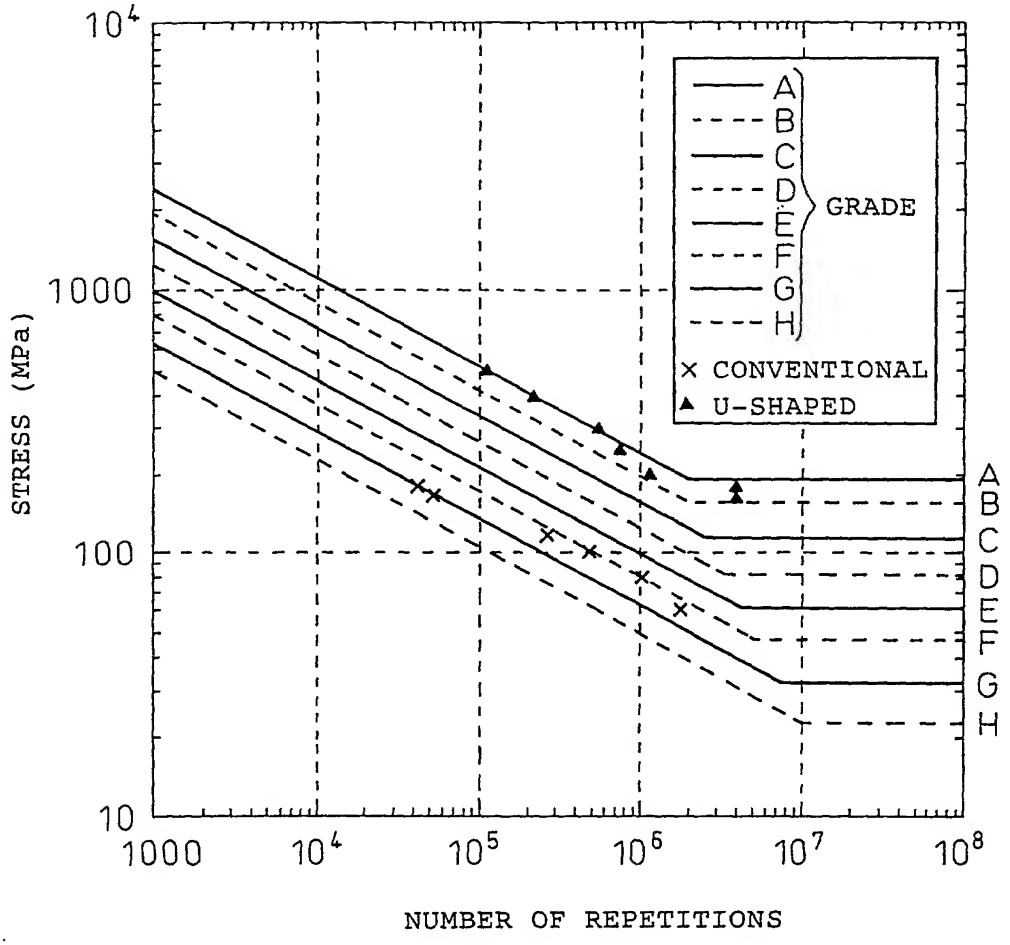


Fig.22

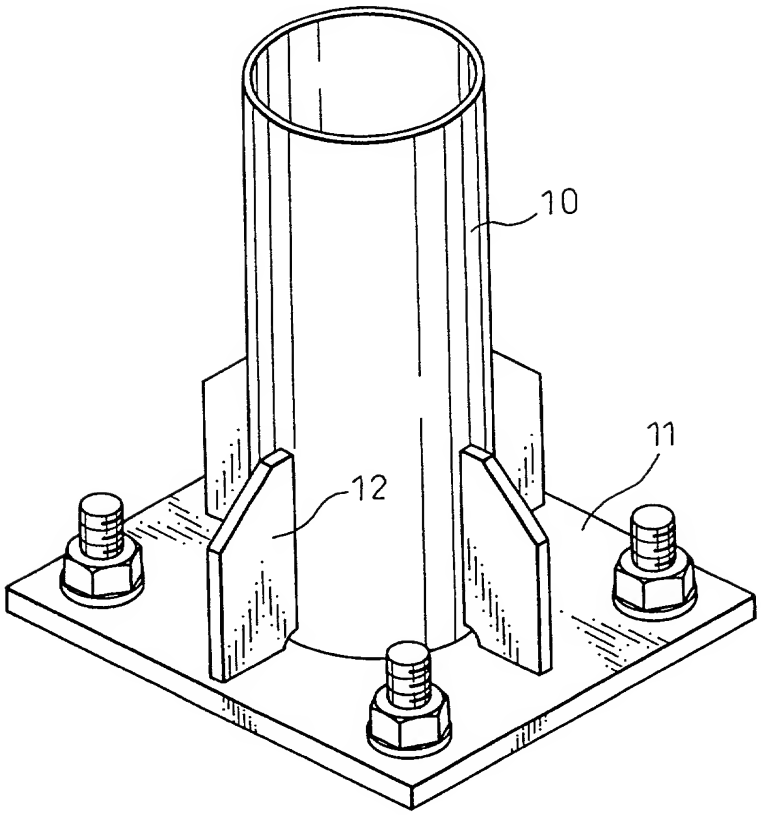


Fig. 23

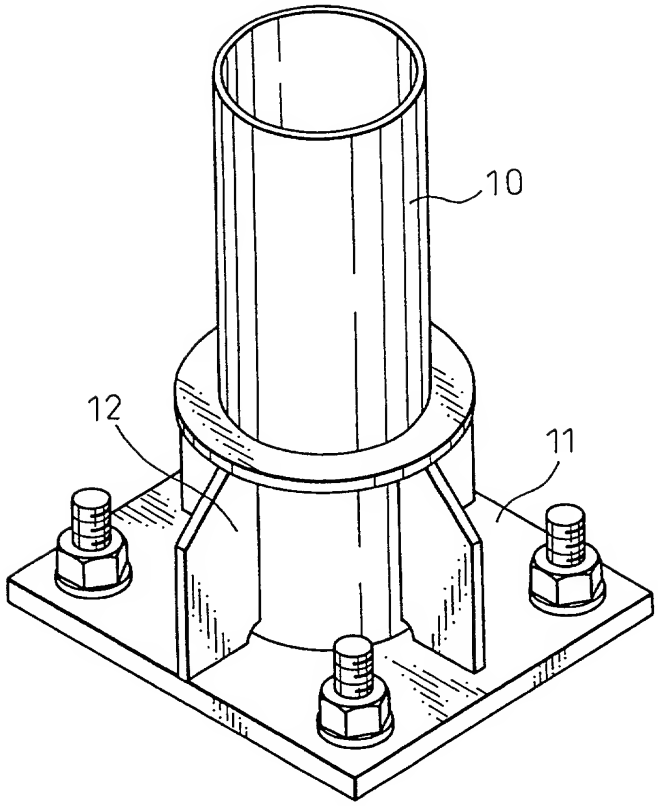


Fig. 24

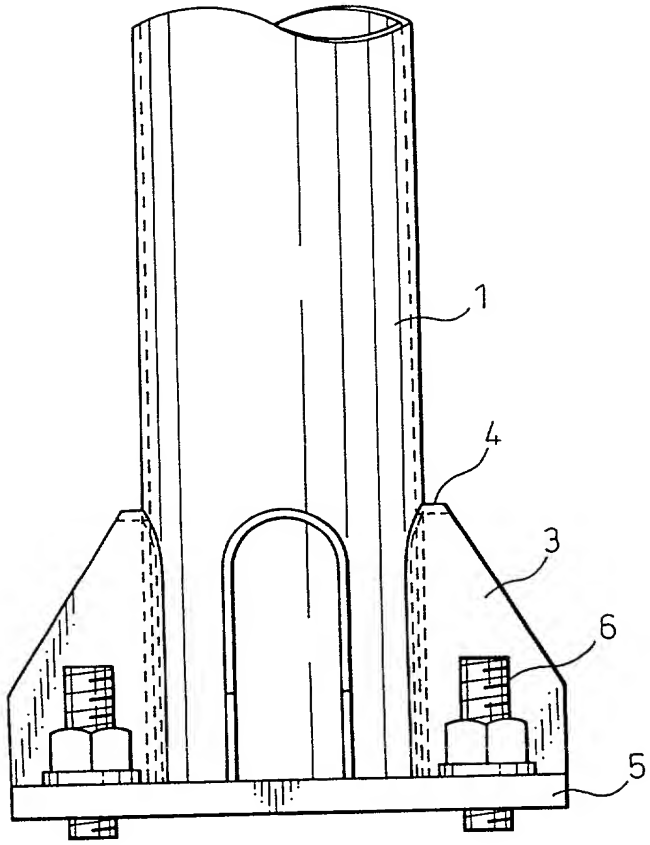


Fig. 25

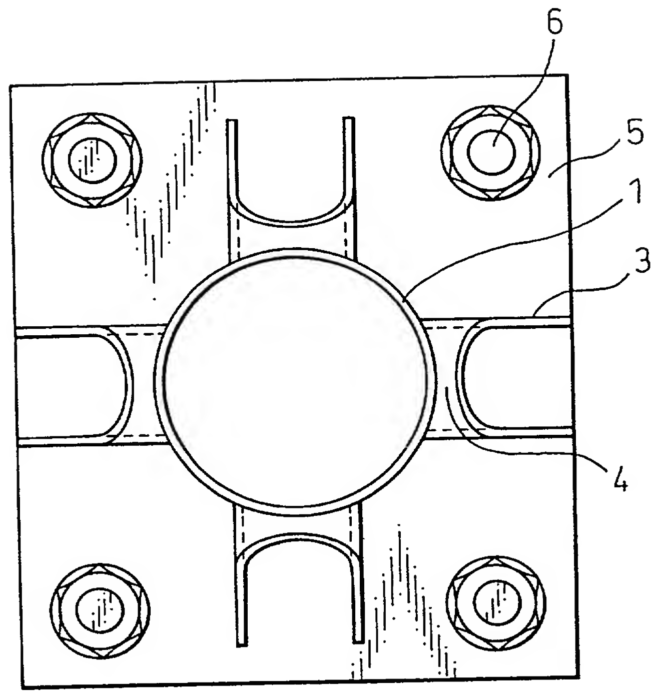


Fig. 26

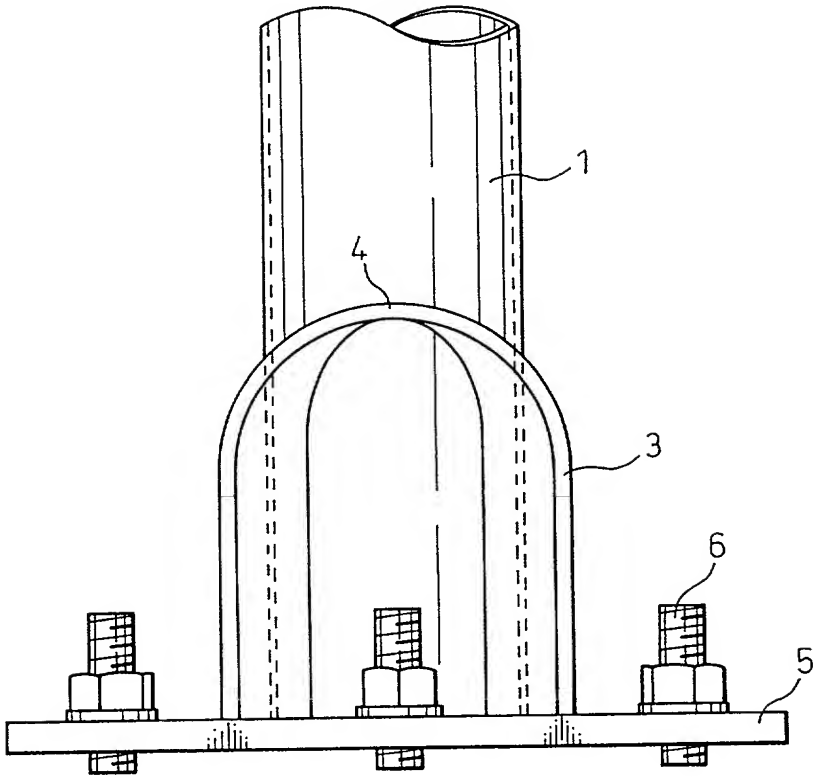


Fig.27

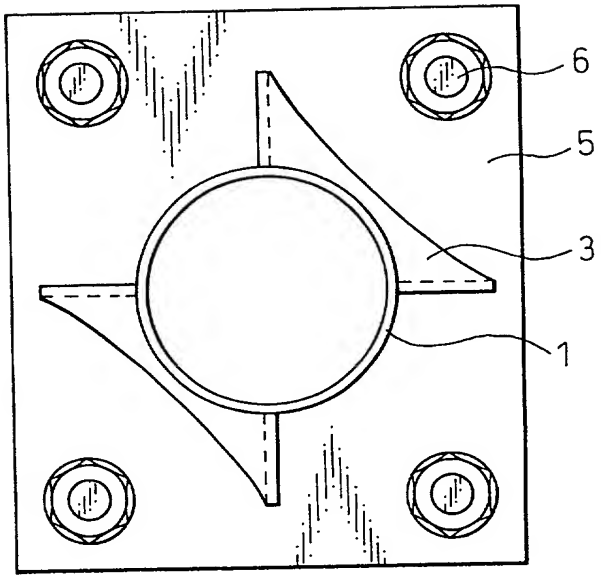


Fig. 28

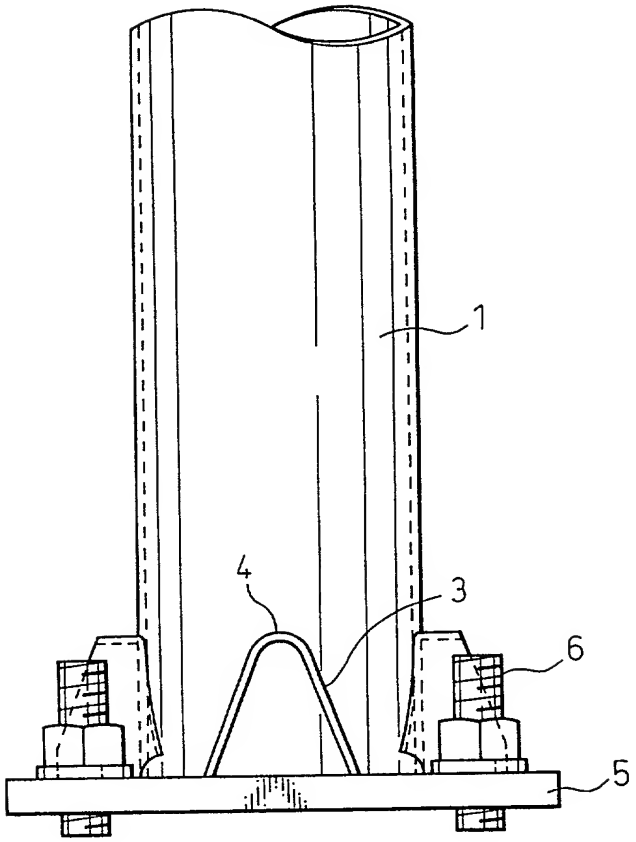


Fig. 29

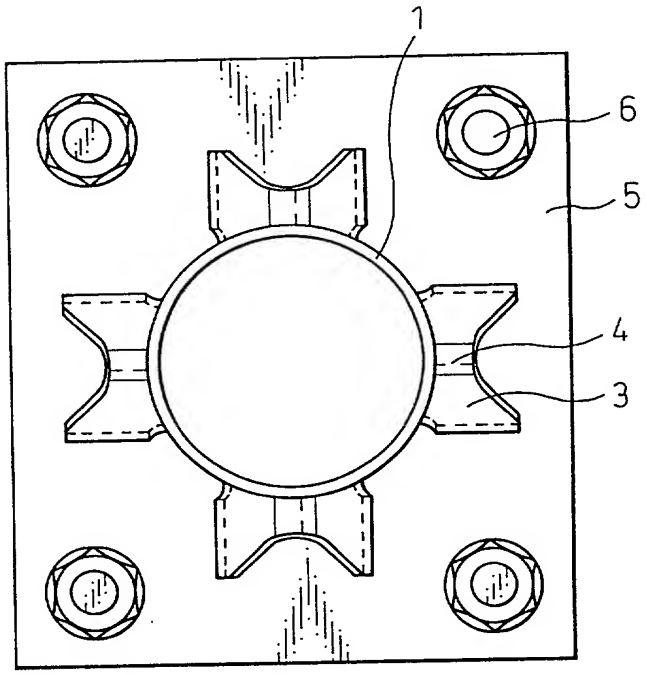


Fig.30

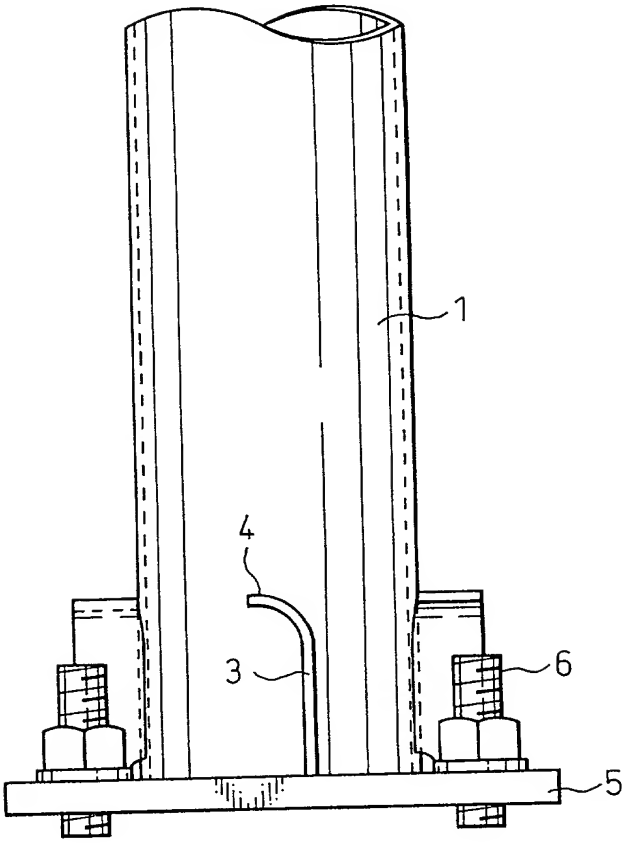


Fig. 31

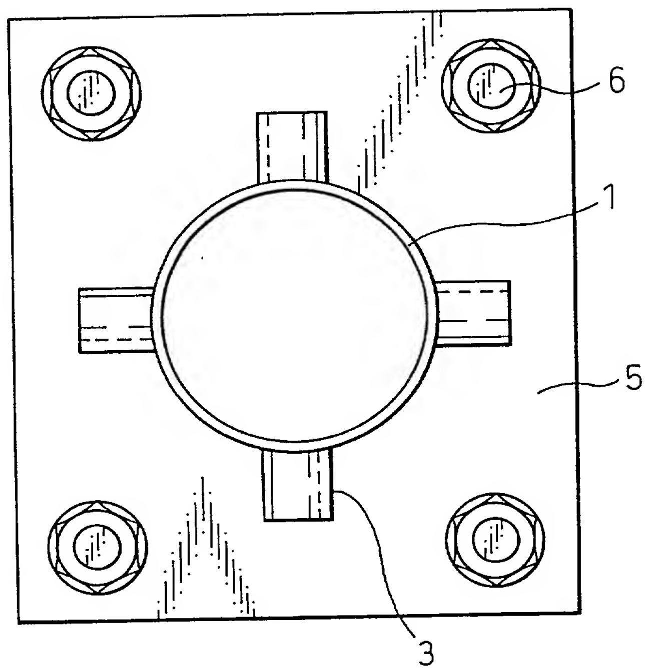


Fig. 32

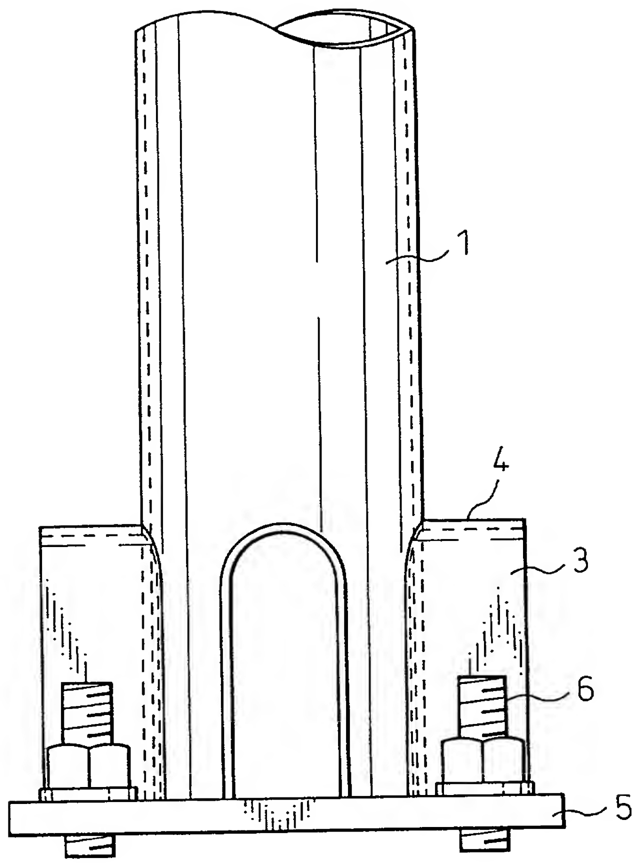
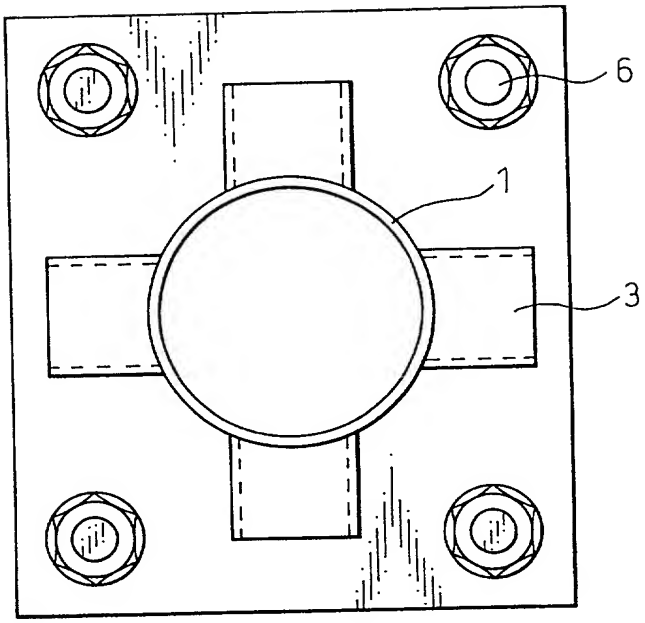


Fig. 33



(Kenyon - NSC)

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Declaration and Power of Attorney for Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

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As a below named inventor, I hereby declare that:

私の住所、郵便の宛先そして国籍は、私の氏名の後に記載された通りである。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明について、特許請求範囲に記載され、且つ特許が求められている発明主題に関して、私は、最初、最先且つ唯一の発明者である（唯一の氏名が記載されている場合）か、或いは最初、最先且つ共同発明者である（複数の氏名が記載されている場合）と信じている。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

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上記発明の明細書はここに添付されているが、下記の箱がチェックされている場合は、この限りでない：

the specification of which is attached hereto unless the following box is checked:

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この出願の米国出願番号またはＰＣＴ国際出願番号は、
_____ であり、且つ
_____ の日に補正された出願（該当する場合）

☒ was filed on August 25, 2000
as United States Application Number or
PCT International Application Number
PCT/JP00/05774 and was amended on
_____ (if applicable).

私は、上記の補正書によって補正された、特許請求範囲を含む上記明細書を検討し、且つ内容を理解していることをここに表明する。

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I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filling date before that of the application for which priority is claimed.

Prior Foreign Application(s) 外国での先行出願 (Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日／月／年)	Priority Not Claimed 優先権主張なし
11-239894 (Pat.Appln.)	Japan	26 / August / 1999	☐
2000-173592 (Pat.Appln.)	Japan	09 / June / 2000	☐

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I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filling Date) (出願日)

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(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可、係属中、放棄)

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number).

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発明者の署名 日付	Inventor's signature: Masakazu Sugimoto Date: February 12, 2002
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国籍	Citizenship: Japanese
郵便の宛先	Post Office Address: c/o NIPPON STEEL CORPORATION Technical Development Bureau, 20-1, Shintomi, Futtsu-shi, Chiba 293-8511, Japan
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第二共同発明者の署名 日付	Second inventor's signature: Masayuki Okimoto Date: February 12, 2002
住所	Residence: Chiyoda-ku, Tokyo, Japan JPX
国籍	Citizenship: Japanese
郵便の宛先	Post Office Address: c/o NIPPON STEEL CORPORATION, 6-3, Otemachi 2-chome, Chiyoda-ku, Tokyo 100-8071, Japan

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国　籍		Citizenship Japanese
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第四共同発明者	日付	Fourth inventor's signature Date Shiro Kita February 12, 2002
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第五共同発明者	日付	Fifth inventor's signature Date Masafumi Higasa February 12, 2002
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国　籍		Citizenship Japanese
私書箱		Post Office Address c/o INABA ELECTRIC WORK, 1-1, Itachibori
		3-chome, Nishi-ku, Osaka-shi, Osaka 550-0012, Japan
第六共同発明者		Full name of sixth joint inventor, if any
第六共同発明者	日付	Sixth inventor's signature Date
住　所		Residence
国　籍		Citizenship
私書箱		Post Office Address

(第七以降の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for seventh and subsequent joint inventors.)